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DEPARTMENTS.

SOLUTIONS OF PROBLEMS.

ARITHMETIC.

137. Proposed by G. B. M. ZERR, A. M., Ph. D., Professor of Chemistry and Physics, The Temple College, Philadelphia, Pa.

At the corners of a triangle sides a, b, c feet, are towers d, e, f feet high. At what point must a ladder be placed so that it will just reach to the top of each tower without moving? How long is the ladder? Substitute $a=200, b=180, c=150, d=60, e=50, f=30; d, e, f$ at A, B, C , respectively.

Solution by the PROPOSER.

Let ABC be the triangle, $AD=d, BE=e, CF=f$, the towers. Join DF, EF , and draw UF parallel to AC , TF parallel to BC . From G , the mid-point of DF , draw GK parallel to AD , GL perpendicular to DF . From H , the mid-point of EF , draw HM parallel to BE , HN parallel to EF . Draw ON perpendicular to BC , and OL perpendicular to AC . Then O is the required foot of the ladder. For O is equally distant from D, E, F , since OL is perpendicular to the plane $ADFC$ at L , and ON is perpendicular to the plane $BCFE$ at N . Draw LR, AV perpendicular to BC , OP perpendicular to LR .

Then $DU=d-f, EF=e-f, GK=\frac{1}{2}(d+f), HM=\frac{1}{2}(e+f)$.

In the similar triangles LGK and DFU , $LK:GK=DU:UF$.

$$\therefore LK = \frac{d^2 - f^2}{2b}, \quad CL = \frac{1}{2}b + \frac{d^2 - f^2}{2b} = \frac{b^2 + d^2 - f^2}{2b}.$$

$$\text{Similarly } MN = \frac{e^2 - f^2}{2a}, \quad CN = \frac{1}{2}a - \frac{e^2 - f^2}{2a} = \frac{a^2 + f^2 - e^2}{2a}.$$

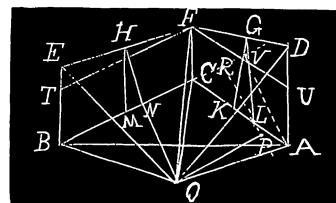
$$AV = \frac{2\Delta}{a}, \text{ where } \Delta = \text{area } ABC. \quad VC = \sqrt{\frac{b^2 - 4\Delta^2}{a^2}}.$$

$$\therefore VC = \frac{a^2 + b^2 - c^2}{2a}. \quad RC:LC = VC:AC.$$

$$\therefore RC = \frac{(b^2 + d^2 - f^2)(a^2 + b^2 - c^2)}{4ab^2}.$$

$$RN = OP = RC + NC = \frac{(b^2 + d^2 - f^2)(a^2 + b^2 - c^2) + 2b^2(a^2 + f^2 - e^2)}{4ab^2}.$$

$$OL:OP = AC:AV.$$



$$\therefore OL = \frac{(b^2 + d^2 - f^2)(a^2 + b^2 - c^2) + 2b^2(a^2 + f^2 - e^2)}{8 \Delta b}.$$

$$OF = \sqrt{OL^2 + CL^2 + CF^2}.$$

When $a=200$, $b=180$, $c=150$, $d=60$, $e=50$, $f=30$,

$$OL^2=60363.9509, CL^2=9506.25, CF^2=900.$$

$$\therefore OF=266.03 \text{ feet.}$$

Also solved by *J. SCHEFFER*.

136. Proposed by **F. M. PRIEST**, Mona House, St. Louis, Mo.

"A pound of gold may be drawn into a wire that would extend around the earth." What would be the diameter of such a wire if the specific gravity of gold is 19.36 and the distance is 24,900 miles?

Solution by **J. M. ARNOLD**, Crompton, R. I.; **G. B. M. ZERR**, A. M., Ph. D., Professor of Chemistry and Physics, The Temple College, Philadelphia, Pa.; and **J. SCHEFFER**, A. M., Hagerstown, Md.

62.4 pounds=weight of 1 cubic foot of water. Then, the specific gravity of gold being 19.36, the weight of 1 cubic foot of gold is 19.36×62.4 pounds, or 1208.064 pounds.

Hence, in 1 pound of gold there are $\frac{1728}{1208.64}$ or 1.43039 cu inches nearly.

$$\therefore \frac{4}{3}\pi d^2 \times 24900 \times 5280 \times 12 = 1.43039 \text{ cubic inches.}$$

$$\therefore d=0.000034 \text{ inches, nearly.}$$

Mr. Arnold remarks that to measure so small a quantity one would have to estimate 1-12 of one of the divisions of a Brown and Sharp's Micrometer Gage, which reads to the hundredth of a millimeter.

Also solved by *ELMER SCHUYLER*.

139. Proposed by **F. P. MATZ**, M. Sc., Ph. D., Professor of Mathematics and Astronomy in Irving College Mechanicsburg, Pa.

The ratio of the interest to the true discount on a certain principal for a certain time at a certain rate per cent. per annum, is $m=21$ to $n=20$. What is the rate per cent.?

Solution by **P. S. BERG**, B. Sc., Principal of Schools, Larimore, N. D.; and **ELMER SCHUYLER**, M. Sc., Professor of Mathematics, Boys' High School, Reading, Pa.

Let P be the principal ; r , the rate ; and t , the time in years.

Then the interest, I , is trP .

The true discount $= \frac{trP}{1+rt}$. $\therefore trP : \frac{trP}{1+rt} = m : n = 21 : 20$.

$$\therefore 1+rt = m/n = \frac{21}{20}, \text{ and } rt = \frac{m-n}{n} = \frac{1}{20}, \text{ or } r = \frac{1}{20t}.$$

Thus r depends on the time.

If $t=1$ year, $r=5\%$.

Also solved by *G. B. M. ZERR*, *J. M. ARNOLD*, and *J. SCHEFFER*.